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BIO-EFFICACY OF FUNGICIDES IN MANAGEMENT OF BLACK MOULD ROT (*ASPERGILLUS NIGER*) OF ONION

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ABSTRACT

Black mould rot of onion incited by Aspergillus niger is an important post-harvest disease of onion under storage conditions. After harvest of the bulbs when they are preserved for longer duration, many fungal and bacterial pathogens cause deterioration of bulbs. Therefore, the study was undertaken to manage black mould rot of onion through chemicals in vitro and in vivo. Among the fungicides screened carbendazim, carbendazim (12%) + mancozeb (63%), mancozeb (50%) + carbendazim (25%), azoxystrobin (18.2%) + difenconazole (11.4%), trifloxystrobin (25%) + tebuconazole (50%) at 500 and 100 ppm and hexaconazole, propiconazole at 1000 and 1500 ppm concentrations completely inhibited the mycelial growth of A. niger over control. In pre-inoculation treatment, no black mould rot severity was recorded in bulbs treated with carbendazim, trifloxystrobin (25%) + tebuconazole (50%), azoxystrobin (18.2%) + difenconazole (11.4%) at 500 and 1000 ppm and hexaconazole, propiconazole at 1500 and 2000 ppm concentrations, respectively over control (32.67 & 60.67 %). Similar trend of results was noted in post-inoculation treatment.

KEYWORDS: Aspergillus Niger Black Mould Rot Fungicides Onion

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Original Article

INTRODUCTION

Onion (*Allium cepa* L.) is an important vegetable crop widely cultivated and used in the world. After harvest of the bulbs when they are preserved for longer duration, many fungal and bacterial pathogens cause deterioration of bulbs. Black mould rot is the most destructive disease of onion in storage as well as under field conditions (Wani and Nisa, 2011). Quadri *et al*., (1982) revealed that the spoilage caused by *A. niger* was as high as 80 per cent. Onion black mould rot disease can occasionally be seen in the field at harvest; it is primarily a post-harvest disease and can cause extensive losses in storage under tropical conditions (Thamizharasi and Narasimham, 1992). Rajam (1992) reported that among the post-harvest diseases of onion, black mould rot caused by *A. niger* was the predominant one. So far, no any effective management practices have been found suitable to control black mould rot of onion during storage. Therefore, the present study was undertaken.

MATERIALS AND METHODS

***In vitro*:** Efficacy of systemic and non-systemic fungicides was tested *in vitro* by "Poisoned food technique method" (Nene and Thapliyal, 1979) against *A. niger* with different concentrations (500, 1000, 1500 & 2000 ppm). Observations on per cent growth inhibition were recorded after 7 days of incubation. The per cent growth inhibition (PGI) of pathogen in each treatment was calculated by following the method suggested by

Asalmol *et al*., (1990).

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Inhibition per cent

C = Colony diameter (mm) in control plate

T = Colony diameter (mm) in treated plate

***In Vivo*:** The fungicides which found promising *in vitro* were further tested to study their efficacy in controlling black mould rot of onion (Waghunde *et al.*, 2014).

Pre-Inoculation: The healthy, mature, uniform size onion bulbs of Nasik red variety were surface sterilized by dipping in 1 per cent NaOCl solution for one min. followed by three successive washings with distilled sterile water then first dipped separately in fungicidal solution for five minutes, air dried and after 12 hrs., the treated bulbs were inoculated with black mould rot pathogens (10^6 spores/ml) by random pin pricking method and then bagged in sterilized polythene bags along with sterilized moist absorbent cotton swab. The mouth of the bag was loosely tied with rubber bands and inoculated bulbs were incubated at room temperature.

Post-Inoculation: Healthy, mature uniform size onion bulbs of Nasik red variety were first inoculated with pathogen (10^6 spores/ml) and after 12 hrs., the inoculated bulbs were dipped in fungicidal solution separately for five minutes. The treated bulbs were bagged separately as described earlier. Observations on percent disease severity were recorded after 7th and 14th days of inoculation with the help of standard assessment key.

Standard Key Used for Assessment of Black Mould Rot Severity: (Wani and Nisa, 2011)

Table 1

Grade	Extent of Rotting	Numerical score (%)
0	No rotting	0
1	Pin head to 10 mm	10
2	Up to 1/4th of the onion bulb	25
3	Up to 1/2 of the onion bulb	50
4	Up to 3/4th of the onion bulb	75
5	More than 3/4th of the onion bulb	100

$$\text{Black mould rot severity (\%)} = \frac{\text{Area of infected bulbs}}{\text{Total area of bulb tissue}} \times 100$$

RESULTS AND DISCUSSIONS

***In vitro*:** Nine fungicides with different concentrations (500, 1000, 1500 & 2000 ppm) along with control were screened to study their efficacy on mycelial growth of *A. niger in vitro* following standard poisoned food technique. The observations on the mycelium growth and per cent growth inhibition (PGI) recorded after seven days of incubation and the results obtained are presented in Table 1, Plate 1 and 2. Among all the fungicides screened seven were found superior in inhibiting the mycelial growth of *A. niger* over control. Carbendazim, carbendazim (12%) + mancozeb (63%),

hexaconazole, propiconazole, mancozeb (50%) + carbendazim (25%), azoxystrobin (18.2%) + difenconazole (11.4%) and trifloxystrobin (25%) + tebuconazole (50%) at both the concentrations (500 & 1000 ppm) completely inhibited the mycelial growth of *A. niger* over control. Metiram (1.85 & 0.74 %) and mancozeb (18.52 & 46.30 %) found least effective in inhibiting the mycelial growth of *A. niger* at both the concentrations (1500 & 2000 ppm). Results similar to the present findings have been reported by Raju and Naik (2006). They tested systemic fungicides against *A. niger,* among all carbendazim 12% + mancozeb 63% (0.10 %) found most effective in inhibiting the radial growth (100%) followed by benomyl (99.59%) and carbendazim (98.81%). According to Patel, (2009) incorporation of carbendazim (12%) + mancozeb (63%) at 500 to 1000 µg/ml concentrations gave complete mycelial growth inhibition of *A. niger.* Wani and Nisa (2011) screened systemic and non-systemic fungicides against *A. niger*, among all carbendazim at 500 ppm concentration gave complete mycelial growth inhibition. Nandeesha *et al*., (2013) observed that carbendazim, hexaconazole, and tebuconazole at 250 ppm concentration found most effective against *A. niger* isolated from groundnut *in vitro* through poisoned food technique. Shazia *et al*., (2014) reported that carbendazim at 800 ppm concentration gave complete mycelial growth inhibition of *A. niger* through poisoned food technique.

Table 2: Bio-Efficacy of Fungicides Against Mycelial Growth of *A. Niger in Vitro*

Sr. No.	Treatments	Concentration (ppm)	Radial Growth (mm) 7 DAI*	Per Cent Growth Inhibition (PGI)
1	Carbendazim (CBZ)	500	00.00	100.00
		1000	00.00	100.00
2	Mancozeb (MNZ)	1500	73.33	18.52
		2000	48.33	46.30
3	Carbendazim (12%) + Mancozeb (63%) (CBZ + MNZ)	500	00.00	100.00
		1000	00.00	100.00
4	Metiram (MTR)	1500	88.33	1.85
		2000	89.33	0.74
5	Hexaconazole (HXZ)	1000	00.00	100.00
		1500	00.00	100.00
6	Propiconazole (PCZ)	1000	00.00	100.00
		1500	00.00	100.00
7	Mancozeb (50%) + Carbendazim (25%) (MNZ + CBZ)	500	00.00	100.00
		1000	00.00	100.00
8	Azoxystrobin (18.2%) + Difenconazole (11.4%) (AXS + DCZ)	500	00.00	100.00
		1000	00.00	100.00
9	Trifloxystrobin (25%) + Tebuconazole (50%) (TFS + TCZ)	500	00.00	100.00
		1000	00.00	100.00
10	Control	-	90.00	00.00
	S.Em. ±	-	**1.157**	-
	C.D. at 5%	-	**3.314**	-
	C.V. %	-	**9.782**	-

***DAI= Days after inoculation**

***In vivo*:** Seven fungicides which were found most effective *in vitro* were further tested to study their efficacy in controlling black mould rot of onion by following both pre- and post-inoculation methods. **Pre-Inoculation:** The results presented in Table 2 revealed that after 7th and 14th day of inoculation, no black mould rot severity was recorded in bulbs treated with carbendazim, trifloxystrobin (25%) + tebuconazole (50%), azoxystrobin (18.2%) + difenconazole (11.4%) at 500 and 1000 ppm and hexaconazole, propiconazole at 1500 and 2000 ppm concentrations over control (32.67 & 60.67 %).

The next best fungicide in order of merit was carbendazim (12%) + mancozeb (63%) (3.32, 4.16 % and 2.38, 3.10 %).

Post-Inoculation: Similar trend of results was obtained in post-inoculation treatment. No black mould rot severity was recorded in bulbs treated with carbendazim, trifloxystrobin (25%) + tebuconazole (50%), azoxystrobin (18.2%) + difenconazole (11.4%) at 500 and 1000 ppm and hexaconazole, propiconazole at 1500 and 2000 ppm concentrations. The next best fungicide in order of merit was carbendazim (12%) + mancozeb (63%) (3.51, 5.89 % and 2.28, 5.58 %) after 7^{th} and 14^{th} days of inoculation.

Table 3: Bio-Efficacy of Fungicides in Management of Black Mould Rot of Onion *in Vivo*

Sr. No.	Treatments	Black Mould Rot Severity (%)							
		Pre-Inoculation				Post-Inoculation			
		500 ppm		1000 ppm		500 ppm		1000 ppm	
		7 DAI*	14 DAI	7 DAI	14 DAI	7 DAI	14 DAI	7 DAI	14 DAI
1	Carbendazim (CBZ)	0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
2	Carbendazim (12%) + Mancozeb (63%) (CBZ + MNZ)	3.32 (1.95)	4.16 (2.16)	2.38 (1.69)	3.10 (1.89)	3.51 (2.00)	5.89 (2.53)	2.28 (1.66)	5.58 (2.46)
3	Trifloxystrobin (25%) + Tebuconazole (50%) (TFS+TCZ)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
4	Azoxystrobin (18.2%) + Difenconazole (11.4%) (AXS+DCZ)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
5	Mancozeb (50%) + Carbendazim (25%) (MNZ+CBZ)	32.33 (5.73)	49.00 (7.03)	32.67 (5.76)	34.67 (5.93)	32.67 (5.76)	57.00 (7.52)	26.00 (5.15)	43.00 (6.59)
		1000 ppm		1500 ppm		1000 ppm		1500 ppm	
		7 DAI*	14 DAI	7 DAI	14 DAI	7 DAI	14 DAI	7 DAI	14 DAI
6	Hexaconazole (HXZ)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
7	Propiconazole (PCZ)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
8	Control	32.67 (5.76)	60.67 (7.82)	32.67 (5.76)	60.67 (7.82)	31.67 (5.58)	60.67 (7.82)	31.67 (5.67)	60.67 (7.82)
	S.Em. ±	**0.053**	**0.049**	**0.055**	**0.063**	**0.023**	**1.02**	**0.044**	**0.043**
	C.D. at 5%	**0.160**	**0.146**	**0.163**	**0.190**	**0.070**	**2.16**	**0.131**	**0.129**
	C.V. %	**4.359**	**3.294**	**4.513**	**4.582**	**1.926**	**8.06**	**3.793**	**2.912**

***DAI= Days after inoculation**

****Figures in parentheses are square root transformed ($\sqrt{X + 0.5}$) values**

CONCLUSIONS

Results of present investigation are in aggrement with the results reported by Srinivasan and Shanmugam (2006). They found that carbendazim (0.1 %) was most effective against black mould rot when applied either as foliar spray in standing crop of onion or as a post-harvest dip. Ahir and Maharshi (2008) reported that pre-harvest application of carbendazim + mancozeb at 0.2 per cent concentration found most effective against black mould rot of onion caused by *A. niger.* Maharshi *et al.* (2009) reported that carbendazim (1000 ppm) gave complete control of blue mould rot (*Penicillium italicum*) of kinnow mandarin followed by carbendazim 12 % + mancozeb 63 % (1000 ppm) in both pre- and post- inoculation treatments. Verma and Tikoo (2003) reported pre inoculation treatment of carbendazim (0.05 %) found most effective against *P. digitatum* infecting mandarin orange than post-inoculation treatment. Pre harvest sprays of saaf (0.1 %), benomyl (0.1 %), carbendazim (0.1 %) and mancozeb (0.2 %) gave 100, 100, 87.4 and 73.38 per cent disease reduction over control, respectively at 15 days of storage against *P. digitatum* on onion in storage conditions (Raju and Naik, 2006).

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